CLAIMS

1. A device for thermal overload protection of an electrical device, particularly an electric motor (M), the device comprising means (10) for measuring at least one load current supplied to the electrical device (M), means (16) for calculating the thermal load on the electrical device on the basis of said at least one load current, and means (S2) for interrupting a current supply (L1, L2, L3) when the thermal load reaches a given threshold level, **charac-terized** in that the device comprises a processor system employing X-bit, preferably X=32, fixed-point arithmetic, the system comprising means for scaling the current measured into unit values to a range of 0 to Y, wherein Y represents Y/100% of a nominal current, and means for calculating a time-to-trip in accordance with formula

$$\tau = R^*C^* \ln (a)$$

$$a = 1 - \left(\frac{\Theta_{trip} - \Theta}{i^2 - \Theta} \right)$$

wherein

Θ_{trip} = trip level for thermal load

Θ = calculated thermal load

τ = estimated time to moment when Θ reaches trip level Θ_{trip}

ΔT = interval for thermal load calculation

R = cooling factor of electrical device

C = trip-class factor

i = measured current

whereby the equation and its operands are programmed into the microprocessor system structured such that a result or a provisional result never exceeds the X-bit value.

2. A device as claimed in claim 1, **characterized** in that one or more following operand values are used

Θ = 0 to 200% preferably corresponding to a value range of 0 to 2.4

ΔT = interval for thermal load calculation in milliseconds

R = cooling factor of electrical device in a range of 1 to 10.

3. A device as claimed in claim 1 or 2, **characterized** in that

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the mathematical equation that, together with its operands, is structured such that the result or the provisional result of the calculation of the thermal load never exceeds the 32-bit value is

$$a=1*\text{e10\_SCALING}-(\Theta_{trip}-\Theta)*\text{e10\_SCALING}/(i2/\text{PUCOMP}-\Theta))$$

$$\tau=(R*C*(\log(a)*\text{SCALING}-(\text{LN\_e10}*\text{SCALING})))/-\text{SCALING}$$

wherein

e10_SCALING is scaling factor for function e^{10}

LN_e10 represents function $\ln(e^{10})$

i = measured current scaled into unit value

SCALING is accuracy scaling whose value depends on the required accuracy.

PUCOMP is per-unit compensation.

4. A device as claimed in claim 3, **c h a r a c t e r i z e d** in that one or more following operand values are used

e10_SCALING = 22026

LN_e10 = 10

i = measured current scaled into unit value to range 0 to 65000 corresponding to 0 to 650% of the nominal current,

SCALING = 10000

PUCOMP = 10000.

5. A device as claimed in any one of claims 1 to 4, **c h a r a c t e r - i z e d** in that the device comprises a memory wherein a look-up table is stored including values of function ln(a) for a set of values of parameter a, and that said calculation means are arranged to retrieve a value corresponding to parameter a from the look-up table during the calculation of the equation.

6. A device as claimed in claim 1, 2, 3 or 4, **c h a r a c t e r i z e d** in that C is trip-class factor t_6 multiplied by a constant, preferably 29.5, or calculated by the formula $(1/k) * Te * (Ia/In)^2$, wherein Ia = starting current, In = nominal current, Te = allowed starting time and k = constant, preferably k = 1.22.

7. A method for thermal overload protection of an electrical device, particularly an electric motor, the method comprising

measuring at least one load current supplied to the electrical device,

calculating the thermal load on the electrical device on the basis of said at least one load current, and

interrupting current supply to the electrical device when the thermal

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load reaches a given threshold level, **c h a r a c t e r i z e d** by

scaling the measured current into a unit value to a range of 0 to Y, wherein Y represents Y/100% of a nominal current,

calculating the time-to-trip using an X-bit, preferably X=32, processor system employing fixed-point arithmetic, by solving the following equation structured and scaled such that a result or a provisional result never exceeds the X-bit value:

$$\tau = R^*C^* \ln(a)$$

$$a = 1 - \left(\frac{\Theta_{trip} - \Theta}{i^2 - \Theta} \right)$$

wherein

Θ_{trip} = trip level for thermal load

Θ = calculated thermal load

τ = estimated time to moment when Θ reaches trip level Θ_{trip}

ΔT = interval for thermal load calculation

R = cooling factor of electrical device

C = trip-class factor

i = measured current

whereby the equation and its operands are structured such that a result or a provisional result never exceeds the X-bit value.

8. A method as claimed in claim 7, **c h a r a c t e r i z e d** by using one or more of the following operand values

Θ = calculated thermal load 0 to 200% preferably corresponding to a value range of 0 to 2.4

ΔT = interval for thermal load calculation in milliseconds

R = cooling factor of electrical device in a range of 1 to 10.

9. A method as claimed in claim 7 or 8, **c h a r a c t e r i z e d** by

the mathematical equation that, together with its operands, is structured such that the result or the provisional result of the calculation of the thermal load never exceeds the 32-bit value being

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a=1*e10_SCALING-((Θtrip -Θ)*e10_SCALING/(i2/PUCOMP-Θ))
τ=(R*C*(log(a)*SCALING-(LN_e10*SCALING)))/-SCALING
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wherein

e10_SCALING is scaling factor for function e^{10}

LN_e10 represents function $\ln(e^{10})$

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i = measured current scaled into unit value

SCALING is accuracy scaling whose value depends on the required accuracy.

PUCOMP is per-unit compensation.

10. A method as claimed in claim 9, **c h a r a c t e r i z e d** by using one or more of the following operand values

e10_SCALING = 22026

LN_e10 = 10

i = measured current scaled into unit value to range 0 to 65000 corresponding to 0 to 650% of the nominal current,

SCALING = 10000

PUCOMP = 10000.

11. A method as claimed in any one of claims 7 to 10, **c h a r a c - t e r i z e d** by

storing a look-up table including values of function ln(a) for a set of values of parameter a, and

retrieving a value corresponding to parameter a from the look-up table during the calculation.

12. A method as claimed in claim 7, 8, 9 or 10, **c h a r a c t e r - i z e d** by C being trip-class factor t_6 multiplied by a constant, preferably 29.5, or calculated by the formula $(1/k) * Te * (Ia/In)^2$, wherein Ia = starting current, In = nominal current, Te = allowed starting time and k = constant, preferably k = 1.22.